

What is claimed is:

1. A method of forming an interconnect structure in a semiconductor device or package comprising the steps of:
 - providing at least one metallic interconnect element selected from the group consisting of a bond pad, a wire, a lead frame, a ball grid array, a stud bump, TAB, C4 or solder bumps, and combinations of two or more of these;
 - forming on at least one of said interconnect elements a bonding surface layer comprising Cu(N) in an amount effective to substantially inhibit oxidation of underlying metallic layers;
 - forming an electrically conductive bond in the location of said surface layer; and
 - prior to or substantially simultaneous with said bond forming step, decomposing said Cu(N) to substantially increase the conductivity of said layer.
2. The method of claim 1 wherein said interconnect structure comprises a semiconductor package having a die with at least one copper bond pad; a substrate for said die; and a surface layer comprising Cu(N).
3. The method of claim 2 wherein said bond forming step comprises ultrasonic or thermosonic bonding.
4. The method of claim 1 wherein said providing step comprises providing at least one metallic interconnect element formed of copper and wherein said surface layer forming step comprises the step of exposing said surface layer of said copper interconnect element to oxygen to oxidize at least a portion of said surface layer.
5. The method of claim 4 wherein said surface layer forming step further comprises the step of exposing said surface layer to heat prior to or at about the time of said oxygen exposing step.

6. The method of claim 5 wherein said surface layer forming step further comprises the step of exposing said surface layer to nitrogen plasma.

7. The method of claim 5 wherein said surface layer forming step further comprises the step of exposing said surface layer to ammonia.

8. The method of claim 6 or 7 wherein said surface layer forming step further comprises exposing said surface layer to heat prior to or at about the time of said nitrogen exposing step.

9. The method of claim 6 or 7 wherein said nitrogen exposing step comprises exposing said surface layer to anhydrous ammonia.

10. A device for use in the formation of an integrated circuit package having a copper interconnect comprising at least one interconnect element have a bonding surface layer comprising Cu(N).

11. A lead frame for use in the formation of an integrated circuit package, said lead frame comprising a bonding surface layer comprising Cu(N).

12. A wire for use in the formation of an integrated circuit package, said wire comprising a bonding surface layer comprising Cu(N).

13. The wire of claim 12 wherein said Cu(N) is deposited from a gas source containing both nitrogen and copper.

14. The wire of claim 13 in which said copper in said gas source is created by an electrical sputtering method from a copper target.

15. The wire of claim 13 in which said copper in said gas source is produced by evaporation by direct heating or by exposure to a hot filament.
16. The wire of claim 12 in which the Cu(N) is formed by the exposure of a surface layer of Cu to nitrogen plasma.
17. The wire of claim 12 wherein the Cu(N) is formed by forming a surface layer comprising copper oxide and converting at least a portion of said copper oxide to copper nitride.
18. The wire of claim 17 wherein said copper oxide forming step comprises exposing a surface layer comprising Cu to oxygen plasma.
19. The wire of claim 17 wherein said copper oxide forming step comprises exposing a surface layer comprising Cu to hot oxygen gas.
20. The wire of claim 17 wherein said copper oxide forming step comprises exposing a surface layer comprising Cu to an oxidizing agent.
21. The wire of claim 17 wherein said copper oxide forming step comprises electrochemically oxidizing a surface layer comprising Cu.
22. The wire of claim 17 wherein said conversion comprises exposing said copper oxide to nitrogen ions plasma.
23. The wire of claim 17 wherein said conversion comprises exposing said copper oxide to gaseous ammonia.

24. A method of forming an interconnect structure in a semiconductor device comprising the steps of:
 - providing at least one conductive interconnect element;
 - forming on said interconnect element a bonding surface comprising Cu(N); and
 - forming an electrically conductive bond in the location of said bonding surface.
25. The method of claim 24 wherein said conductive interconnect element is metal wire.
26. The method of claim 25 wherein said metal wire comprises copper wire.
27. The method of claim 25 or 26 wherein said bonding surface forming step comprises exposing a surface portion of said wire to a gas containing nitrogen and copper.
28. The method of claim 27 wherein said bonding surface forming step comprises sputtering copper from a copper target onto at least a surface portion of said wire.
29. The method of claim 27 wherein said bonding surface forming step comprises evaporating copper by direct heating and/or by exposure to a hot filament.
30. The method of claim 27 wherein said bonding surface forming step comprises exposing at least a surface portion of said wire to nitrogen plasma.
31. The method of claim 25 or 26 wherein said bonding surface forming step comprises forming on said wire a surface layer comprising copper oxide and converting at least a portion of said copper oxide to copper nitride.
32. The method of claim 31 wherein said copper oxide forming step comprises exposing a surface layer of Cu to oxygen plasma.

33. The method of claim 31 wherein said copper oxide forming step comprises exposing a surface layer of Cu to hot oxygen gas.
34. The method of claim 31 wherein said copper oxide forming step comprises exposing a surface layer of Cu to an oxidizing agent.
35. The method of claim 31 wherein said copper oxide forming step comprises electrochemically oxidizing a surface layer of Cu.
36. The method of claim 31 wherein said conversion comprises exposing said copper oxide to nitrogen plasma.
37. The method of claim 31 wherein said conversion comprises exposing said copper oxide to gaseous ammonia.
38. An improved interconnect structure for use in a semiconductor device comprising a conductive layer and at least one bonding surface in electrical communication with said conductive layer, said bonding surface comprising Cu(N).